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TO: Jeff Catanzarita, U.S. EPA/ERT Work Assignment Manager

THROUGH: Dennis Miller, SERAS Program Manager

FROM: Christopher Gussman, SERAS Task Leader

SUBJECT: SERAS FIELD ACTIVITIES SUMMARY REPORT
LOWER LEY CREEK SUPERFUND SITE
WA # SER0007 – TRIP REPORT

Introduction

Lockheed Martin Scientific, Engineering, and Analytical Services (SERAS) personnel, under the guidance of the U.S. Environmental Protection Agency's (U.S.EPA's) Environmental Response Team (ERT), recently conducted several sediment, soil, and water sampling events to provide data for a remedial investigation (RI) of the Lower Ley Creek Superfund Site, which is a subset of Ley Creek located in Syracuse, New York. Ley Creek is located on the southeast bank and flows directly into Lake Onondaga. This current effort, which occurred from November 2009 until October 2011, focused on an approximately 2-mile stretch of Ley Creek directly upstream of the lake ("Lower" Ley Creek). The RI will be conducted under the direction of the State of New York State's Department of Environmental Conservation (NYSDEC) and U.S.EPA Region II.

Purpose

The purpose of this report is to present sampling activitiesand studies which occurred as part of this RI, including investigations to identify and determine the distribution of chemical parameters of interest (CPOIs) in water, sediment, soil, and fish tissue along Lower Ley Creek. Data from the sampling events were also used in a Human Health Risk Assessment (HHRA) and a streamlined Baseline Ecological Risk Assessment (BERA) included as appendices. The CPOIs are those elements or compounds that were selected as Contaminants of Potential Concern (COPCs) or Contaminants of Concern (COCs). SERAS personnel began work at the site in November 2009 sampling sediment, water, and biota (fish) in Lower Ley Creek. Additional sediment was collected within Lower Ley Creek in May 2010 using a vibracore to collect samples at a deeper depth (to 8-feet below sediment surface [bss]) and to collect sediment samples for a toxicity study. During this May 2010 sampling event, sediment was also collected along a swale which runs into Lower Ley Creek. High concentrations of COCs were found within the swale sediments and the swale area was further investigated in August 2010 when sediment and soil samples were collected in and around the northeast section of the swale. A final sampling investigation occurred in October 2011. This last investigation focused on soil and sediments along the banks of Lower Ley Creek, primarily where sediments dredged from the creek may have been deposited at one time. In addition, three vibracore™ samples were collected within the previously sampled northeast portion of the creek in the area of interest to better determine the depth of contamination in this section of creek just downstream of Brewerton Road.

Site Background

The focus of this investigation, the Lower Ley Creek Site, consists of channel sediments and surface water, and floodplain soil/sediment from the Brewerton Road (U.S. Route 11) bridge downstream to Onondaga Lake, passing through Salinas Landfill within these boundaries. This represents the furthest downstream section of Ley Creek before it reaches Lake Onondaga. Ley Creek has been impacted and influenced by a number of facilities located near the creek including the General Motors (GM) Inland Fisher Guide facility as well as others. The general surroundings of the Lower Ley Creek Site are urbanized and include many industries. The GM facility operated between 1952 and 1993. Initially it operated as a plating facility and later was used for the manufacture of plastic automotive components. Lower Ley Creek has received a wide range of contaminants, principally in the form of PCBs and heavy metals. PCBs (Aroclors 1016, 1248, 1254, and 1260) were detected in Lower Ley Creek at concentrations as high as 360,000 micrograms per kilogram (ug/kg). The Onondaga Lake Remedial Investigation report estimated PCB loads of 23 kilograms per year (kg/yr), 3.3 kg/yr, and 1.1 kg/yr of Aroclors 1016, 1242, and 1260, respectively. Cadmium, chromium, copper, lead, mercury, and nickel were also detected at elevated levels in Ley Creek sediment. Sediment data from samples collected near the mouth of Ley Creek suggest that Ley Creek is a source of Polychlorinated Dibenzo-Dioxin/Polychlorinated Dibenzo-Furans (PCDD/PCDFs) to Onondaga Lake. Based on the above, Ley Creek is a source of PCBs, heavy metals, and a likely source of PCDD/PCDFs to the lake, and may be contributing to unacceptable human health and ecological risks in Onondaga Lake due to consumption of fish.

Site Description

The site consists of the lower two miles of Lower Ley Creek, beginning at Route 11 (aka Brewerton Road) and continuing downstream to Lake Onondaga. The creek passes through the Salina Landfill and under the 7th North Street Bridge and Interstate 81 (I81) bridges. The stream is somewhat narrow and the channel is very well defined. The bottom of the stream is dominated by soft sediment with very little stone or other hard surfaces. Much of the stream is shallow but there are pockets that may be 8-10 feet deep, particularly below 7th North Street. The creek, in general, is narrower and shallower upstream of 7th North Street, and wider and deeper below 7th North Street. The immediate banks of the stream are bordered predominantly by herbaceous vegetation, of which *Phragmites* dominates. Some woody shrubs are also mixed in with the herbaceous vegetation and sections of the bank are wooded. The banks of the stream channel proper are near vertical in most areas, and the bottom is predominantly soft sediment. Beyond the narrow strip of vegetation, the creek is surrounded by industry: manufacturing, parking lots, the landfill, and also railroad tracks parallel and a short distance from much of the southern bank. The creek turns north and then southwest in the last 500 feet before passing under the railroad tracks and entering Lake Onondaga. The overall site is located within the urbanized location of Eastern Syracuse, New York.

Site History

The salt springs near Onondaga Lake have supported a major salt recovery industry that thrived during the nineteenth century and over time led to extensive development within the Syracuse Region. The development of railroads and the Erie Canal System allowed additional industry and settlement to quickly grow in the area. Many of these industries were focused around and near Onondaga Lake and included various chemical and pharmaceutical manufacturers among other industries. The Onondaga Lake area experienced further residential and economic growth during the twentieth century and the population of Onondaga County rose from approximately 160,000 in 1900 to 458,336 in 2000 (US Census Bureau, 2002), much of which is centered around the lake. The industrial nature of this area, as well as the infrastructure and other development, influenced the site and contributed to its current compromised condition.

Assessments have been performed or are currently being performed at a number of potential sub-sites in the general area to determine whether they contributed to the contamination of Onondaga Lake. The Onondaga Lake site includes the Lake itself, seven major and other minor tributaries, and various upland sources of contamination to the Lake. The aerial footprint of the lake is approximately 4.5 square miles, with a drainage basin of approximately 233 square miles.

There are several industrial facilities or sites that are known to be either contributors or potential contributors of contaminants to Ley Creek. These include: The General Motors Former Inland Fisher Guide (GM -IFG) Facility and Ley Creek Deferred Media Site, The GM Ley Creek Dredgings Site, The Town of Salina Landfill (which surrounds Lower Ley Creek just downstream of Route 11/Brewerton Road), and the GM - Old Ley Creek Channel Site. A Record of Decision (ROD) for Salina Landfill was signed in 2007, ROD Town of Salina Landfill Site Sub-Site to the Onondaga Lake NPL Site/Town of Salina, Onondaga County Site Number 7-34-036. Lower Ley Creek, also flows through this Landfill and the creek is addressed as part of the ROD. The current investigation includes this section of Ley Creek. There are multiple possible sources of contamination in Lower Ley Creek and therefore eventually potentially contaminating Onondaga Lake from Ley Creek. The Town of Salina established residential refuse districts as early as 1941, where the town would solicit bids from independent haulers and enter into a contract each year. The town put a license procedure into place procedure which was used to monitor the waste disposal. When in active operation, the landfill accepted various hazardous wastes including paint sludge, paint thinner, polychlorinated biphenyl (PCB)-contaminated wastes, and contaminated sediment dredged from Ley Creek along with municipal solid waste. According to the Salina Landfill ROD, town records indicate that the trucks with permit stickers were on the "honor system" and were not checked for source or quantity of refuse. The landfill was officially closed sometime in the mid 1970s, by order of the NYSDEC.

Previous Investigations

Several previous and current investigations focus on Onondaga Lake and its surrounding tributaries. No previous investigations focused on this section of creek, although other efforts have occurred along other portions of Ley Creek further upstream. The Salina Landfill ROD overlaps a part of this section of creek. Some previous sampling events occurred within Ley Creek, but this effort is intended to better understand and characterize Lower Ley Creek from Brewerton Road to the mouth of Lake Onondaga.

As summarized in the 2007 ROD for the Salina Landfill, NYSDEC and the Onondaga County Department of Health collected three soil samples adjacent to the north bank of Ley Creek along the landfill and four surface water samples from the same stretch of Ley Creek and drainage ditches north and east of the landfill in 1986. PCBs were not detected in the water samples, but were detected in the soil samples collected adjacent to Ley Creek. In 1987, NUS Corporation collected five soil samples from the main fill area north of Ley Creek and three surface water and sediment samples were collected from Ley Creek. These samples consisted of one surface water and one sediment sample from an upstream location in Ley Creek (west of Route 11), one surface water and one sediment sample were collected alongside the landfill and one surface water and one sediment sample were collected just downstream of the landfill in Ley Creek. The soil samples contained polyaromatic hydrocarbon compounds (PAHs), metals, volatile organic compounds (VOCs) and pesticides in low levels, but no PCBs. In general, surface water and sediment samples collected downstream from the landfill did not contain higher concentrations of contaminants than the samples collected upstream from the landfill.

Contaminant levels in sediment had, in the past, been found to exceed the severe effect limits for aquatic plants and animals. Limited NYSDEC sampling in 1987 and 1997 has shown the presence of PCBs at hazardous waste levels in both the former channel sediments and subsurface soils. In addition, the 1997 former channel sediment sampling showed levels of heavy metals exceeding the DEC Fish & Wildlife Severe Effect Levels (SEL). The current Ley Creek channel sediments were sampled in 1998 as part of the Salina Landfill remedial investigation/feasibility study (RI/FS), and were found to contain levels of PCBs at greater than 80 ppm, chromium at levels greater than 1,700 ppm and other heavy metals exceeding their respective SELs. Access to this site is unrestricted, and the property is next to a public thoroughfare. The site poses a significant threat to both fish and other wildlife and to the public health. Sediments and subsurface soils are contaminated, however, site access is difficult due to thick vegetation. Flow in the channel does not support an attractive fishery which makes trespassing and direct contact with contaminated materials unlikely.

Study Area Investigation

Field investigations were conducted by Lockheed Martin/SERAS personnel under oversight of the EPA/ERT to satisfy data requirements, as set forth in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and applicable EPA guidance, for use in the Lower Ley Creek RI. Field work for this investigation commenced on site in November of 2009 and continued through October 2011. For use in the accompanying Lower Ley Creek streamlined BERA and HHRA, sediment, spoils, water, and fish were sampled from Lower Ley Creek. Sediment data from the November 2009 event demonstrated that the depth of sediment contaminants observed were undetermined. Therefore, additional sediment sampling occurred, at selected locations, in May 2010 to better understand and define the depth of the contaminants in the stream sediment. In addition, sediment sampling occurred in May 2010 along a swale area south of the creek that had not been previously investigated and which potentially could contribute runoff into Lower Ley Creek. Elevated levels of PCBs were found in the northern edge of this swale, so additional sampling of the swale occurred in August 2010 to better define the boundary and depth of contaminants within the swale. A final sampling event occurred in September/October 2011 to investigate the presence and distribution of contaminants along the banks of Ley Creek where dredge spoils may have been deposited.

Contaminant Source Investigations

Source of contaminants are varied and not always easy to determine. PCBs and other contaminants have been historically found upstream of the present site investigation, and the creek passes through a landfill within the boundaries of the investigation. In addition, the area surrounding the stream in the area of interest and upstream of the area of interest is urbanized and may currently receive or historically had received contaminants from various sources.

The current investigation initially utilized a statistically sound method of determining potential "hotspots" within the streambed sediment to better characterize the presence, nature, and extent of contaminants in Lower Ley Creek.

Statistical Support of Sampling Design. A Visual Sampling Plan (VSP) was selected for sediment sampling. For the VSP, Lower Ley Creek was broken into three reaches based on physical and known chemical characteristics. The iteration selected was run looking for a 200 ft. diameter circular hotspot with 95% confidence. It resulted in 30 sample locations although there are some gaps in sampling (where the creek narrows a triangular grid can't be fit). In addition to the 30 sampling locations, the option of selecting additional locations in the field to fill in data gaps and examine locations in the field of interest such as sediment depositional areas. The information below summarizes the VSP design.

Triangular Grid – 95% Confidence – Circular Hot Spot – 200 ft. Diameter

Systematic sampling locations for detecting an area of elevated values (hot spot)

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Detect the presence of a hot spot that has a specified size and shape
Type of Sampling Design	Hot spot
Sample Placement (Location) in the Field	Systematic (Hot Spot) with a random start location
Formula for calculating number of sampling locations	Singer and Wickman algorithm
Calculated total number of samples	20
Type of samples	Point Samples
Number of samples on map [a]	30
Number of selected sample areas [b]	3
Specified sampling area [c]	629327.71 ft^2
Grid pattern	Triangular
Size of grid / Area of grid [d]	193.205 feet / 32327.1 ft^2
Total cost of sampling [e]	Not Applicable (N/A)

[a] This number may differ from the calculated number because of: 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Size of grid / Area of grid gives the linear and square dimensions of the grid spacing used to systematically place samples.

Lower Ley Creek

X Coord	Y Coord	Type
929548.2758	1120653.4848	Hotspot
929258.4686	1120820.8050	Hotspot
930031.2877	1120820.8050	Hotspot
930127.8901	1120988.1253	Hotspot

X Coord	Y Coord	Type
930498.2882	1121474.9333	Hotspot
930594.8906	1121642.2535	Hotspot
930691.4930	1121809.5738	Hotspot
930788.0953	1121976.8940	Hotspot
930884.6977	1122144.2143	Hotspot
930981.3001	1122311.5345	Hotspot
931077.9025	1122478.8548	Hotspot
931560.9145	1122980.8155	Hotspot
931657.5169	1123148.1358	Hotspot
931754.1193	1123315.4561	Hotspot
931850.7217	1123482.7763	Hotspot
931947.3241	1123650.0966	Hotspot
932043.9265	1123817.4168	Hotspot
932140.5289	1123984.7371	Hotspot
932237.1313	1124152.0573	Hotspot
932333.7337	1124319.3776	Hotspot
932430.3360	1124486.6978	Hotspot

X Coord	Y Coord	Type
933211.9323	1125316.4267	Hotspot
933405.1371	1125316.4267	Hotspot
933598.3419	1125316.4267	Hotspot
933791.5467	1125316.4267	Hotspot
933984.7515	1125316.4267	Hotspot
935240.5826	1125818.3875	Hotspot
935530.3898	1125985.7077	Hotspot
935723.5945	1125985.7077	Hotspot
935916.7993	1125985.7077	Hotspot

Primary Sampling Objective
The primary purpose of sampling at this site is to detect "hot spots" (local areas of elevated concentration) of a given size and shape with a specified probability.

Selected Sampling Approach
This sampling approach requires systematic grid sampling with a random start. If a systematic grid is not used, the probability of detecting a hot spot of a given size and shape will be different than desired or calculated.

Number of Total Samples: Calculation Equation and Inputs
The algorithm used to calculate the grid size (and hence, the number of samples) is based on work by Singer and Wickman for locating geologic deposits [see Singer and Wickman (1969) and Hassig et al. (2004) for details]. Inputs to the algorithm include the size, shape, and orientation of a hot spot of interest, an acceptable probability of finding a hot spot, the desired type of sampling grid, and the sampling budget. For this design, the grid size was calculated based on the given hot spot size and other parameters.

The inputs to the algorithm that result in the grid size are:

Parameter	Description	Value
Inputs		
$1-\beta$	Probability of detection	95%
Grid Type	Grid pattern (Square, Triangular or Rectangular)	Triangular
Sample Type	Point samples or square cells	Points
Hot Spot Shape	Hot spot height to width ratio	1
Hot Spot Size	Length of hot spot semi-major axis	100 feet
Hot Spot Area [a]	Area of hot spot ($Length^2$ * Shape * π)	31415.9 ft^2
Angle	Angle of orientation between hot spot and grid	Random
Sampling Area	Total area to sample	629327.71 ft^2
Outputs		
Grid Size	Spacing between samples	193.205 feet
Grid Area	Area represented by one grid	32327.1 ft^2
Samples [b]	Optimum number of samples	19.4675
Cost	Total cost of sampling	N/A

[a] Length of semi-major axis is used by Singer-Wickman algorithm. Hot spot area is provided for informational purposes.
[b] The optimum number of samples is calculated by dividing the sampling area by the grid area.

The following graph shows the relationship between the number of samples and the probability of finding the hot spot. The dashed blue line shows the actual number of samples for this design (which may differ from the optimum number of samples because of edge effects).

Assumptions that Underlie the VSP Locating a Hot Spot Design Method:

1. The shape of the hot spot of concern is circular or elliptical.
2. The level of contamination that defines a hot spot is well defined.
3. The location of the hot spot is unknown, and if a hot spot is present, all locations within the sampling area are equally likely to contain the hot spot.
4. Samples are taken on a square, rectangular or triangular grid pattern.
5. Each sample is collected, handled, measured or inspected using approved methods that yield unbiased and sufficiently precise measurements.
6. A very small proportion of the surface being studied will be sampled (the sample is much smaller than the hot spot of interest).
7. Sample locations are independent of the measurement process.
8. The systematic grid is placed at a randomly determined starting place to cover the surface area of interest.
9. There are no classification errors (if a hot spot is sampled, it is not mistakenly overlooked or an area is not mistakenly identified as a hot spot).

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the probability of hit (%), hot spot shape (height to width ratio) and hot spot size (length of semi-major axis). The following table shows the results of this analysis.

Number of Samples				
		Size=50	Size=100	Size=150
1-β=90	Shp=0.8	95	24	11
	Shp=0.9	82	21	10
	Shp=1	73	19	9
1-β=95	Shp=0.8	104	26	12
	Shp=0.9	89	23	10
	Shp=1	78	20	9
1-β=100	Shp=0.8	126	32	14
	Shp=0.9	109	28	13
	Shp=1	97	25	11

1-β = Probability of Hit (%)
Shp = Hot Spot Shape (Height to Width Ratio)
Size = Hot Spot Size (Length of Semi-major Axis)

FIELD ACTIVITIES

Sampling Dates

The initial sampling event in November 2009 made an effort to collect samples before the onset of potential adverse weather in Syracuse during the winter months. The sampling of stream biota (fish and crayfish) occurred on November 9 and 10, 2009. Sediment and water sampling within Ley Creek occurred during the week of November 16, 2009. The weather was relatively warm and dry for the season during these sampling dates. Additional sampling of deeper sediments and along the swale occurred in May 2010 during seasonable weather. An expanded swale sampling event occurred in August 2010. The final field effort commenced on September 26, 2011 to examine the extent of contamination in soils bordering Ley Creek where dredge spoils may have been deposited historically. At the same time additional sediment sampling occurred within Ley Creek close to Brewerton road, to better define depth of contamination of sediment within the stream channel near sampling location "R2-8" which had been sampled during the May 2010 sampling event. Three sediment cores were collected from this section of stream channel.

Fish Sampling November 2009

EPA's Division of Environmental Science and Assessment (DESA) provided electroshocking equipment for the collection of fish. Two SERAS personnel and an U.S. Fish and Wildlife Biologist participated in the fish collection effort. The weather during the fish collection effort was sunny and unseasonably warm, approximately 68 degrees Fahrenheit, on the dates of sampling. ERT and SERAS personnel assisted with netting the fish. A standard electrofishing barge, Smith-Root model SR-12, equipped with a 5,000 watt (W) generator and two 1 meter (m) diameter umbrella anode arrays was utilized in the relatively deeper, downstream section of the creek from the 7th North Street Bridge to Lake Onondaga. This boat was owned and operated by DESA. A smaller, standard electrofishing tote barge, Smith-Root model SR-6, equipped with a 2,500-W generator and one 11 inch diameter ring anode array attached to a six foot pole was used in the relatively shallower upper section of creek between Rt. 11 (Brewerton Road) and the 7th North Street Bridge. The electroshocker on this smaller barge was operated by U.S. Fish and Wildlife Service personnel. In addition, SERAS personnelset out Frabill crayfish traps baited with canned cat food at select locations along Lower Ley Creek. Fish were netted and placed in either a livewell on the larger boat or large cooler containing river water in the smaller barge. The downstream portion of Lower Ley Creek was accessed from Lake Onondaga during this sampling event and the upstream section accessed from the Route 11 Bridge. The larger boat was put in the water at a dock on Lake Onondaga, south of the mouth of Lower Ley Creek. Fish sampling occurred the afternoon of November 9, 2009 and the morning of November 10, 2009. At the end of each day, selected fish were packed on ice and placed in coolers. On November 10, 2009 these fish were brought back to SERAS facilities where they were frozen at -10 degrees Celsius. The fish samples were later sorted and homogenized the week of December 7, 2009. The fish caught included several very large (3 to 6 pound) carp, many smaller carp, sunfish, white suckers, creek chubs, pike, one brown trout, and an assortment of small "minnow" type and young fish. A complete list of the fish, their species, lengths, weights, and how they were identified and divided for the purpose of sampling may be found in Appendix A. For example, fish sample "1-2-1" is made up of a composite of 5 individual white sucker fish (*Catastomus commersoni*). Only six crayfish were caught in the traps at one location only. Crayfish were therefore not analyzed or utilized in the risk assessments. The fish samples were forwarded to DESA after being homogenized and placed into the appropriate sample jars for analysis.

Sediment and Water Sampling November 2009

Seven SERAS personnel and two ERT personnel began the sediment and water sampling effort on the morning of Monday, November 16, 2009. Utility companies with lines and resources potentially within Lower Ley Creek were contacted the week prior to prevent any potential damage to the utility and water lines. A large, 17-foot box truck was rented to be used as a station for sample management. The EPA developed Visual Sampling Plan (VSP) was for sediment sampling. Visual Sample Plan (VSP) provides statistical solutions to sampling design problems. VSP helps the user select the correct number and location of samples so that a required confidence level for decision-making can be achieved. For this specific VSP, Lower Ley Creek was broken into three reaches based on physical and known chemical characteristics. Field personnel used a zodiac boat or a Jon boat to carry equipment and personnel to each sampling location, which was located by Global Positioning System (GPS). A few of the preselected locations fell outside the river or were otherwise located in an unsuitable location. In these instances, the sample location was moved to the river location closest to the preselected point and the new location recorded by GPS. During the sampling event, a central sample process location was created for processing all of the collected samples. EPA and SERAS personnel initially set up the sample processing location in a riverbank clearing just off of Route 11/Brewerton Road, on the south side of the creek. As sampling progressed further downstream, the processing station was later moved just off of Park Road, under the Route I81 bridge.

Surface water sampling was conducted in accordance with SERAS standard operating procedure (SOP) # 2013, *Surface Water Sampling*. The metals fraction was preserved with nitric acid ($pH < 2$) after collection. The dissolved fraction was obtained by filtering the sample through a dedicated sample filter before pH adjustment. Sediment sampling was conducted in accordance with SERS SOP #2016, *Sediment Sampling*. Samples were collected from three sediment intervals: 0 to 6 inches, 6 to 12 inches, and 18 to 24 inches below the water-sediment interface. Sediment sampling procedures were not initiated until surface water sampling had been conducted at the location, where applicable. The three intervals were collected in an acetate sleeve using a manually driven coring device. At some locations, divers were required for sample collection due to the water depth. The divers were primarily necessary at the lowest reach of the creek. Several samples were also collected in the "Dredge Spoils Area" on the north bank of the creek just east of 7^{th} street. If refusal was met at a sampling location, a second attempt was made within 3-feet of the original effort. However, this was rarely necessary. Enough cores were collected at each location (six to fourteen cores per location) to ensure adequate sample mass for all desired analyses. After collection, the cores were brought back to the processing area for homogenization and distribution into appropriate sampling jars. The depth of the sediment in the core was measured and divided into four equal sections. Sediment often compresses during the sampling effort, therefore two feet of sediment will fill less than 2-feet of core space. The uppermost quarter section represented the 0-6" fraction, the next quarter section represented the 6-12" section, and so on. The cores were cut with an electric saw which was decontaminated between samples. Encore samples for VOCs were obtained directly from the cores. Similar sediment fractions were then combined in an aluminum baking pan and thoroughly homogenized by hand before distributing the sample among appropriate sampling jars. The 12-18" section was not used for analysis and discarded in a stainless steel drum along with any additional leftover sediment. Appropriate duplicates and blanks were included in the sampling effort. Sediment was soft, dark and organic and most locations except for the "R1" locations close to the lake which contained light gray Solvay waste.

Sample jars and Encores were transferred from SERAS to DESA personnel. DESA personnel performed the sample management and shipped the samples to CLP laboratories. All of the sediment and water samples indicated on Figure 1 were collected, processed, and shipped by Thursday, November 19, 2009. Personnel returned home on Friday, November 20, 2009. Figure 1 indicates the sampling locations and Figure 2 indicates the general area where fish were caught.

May 2010 Sediment Sampling

ERT and SERAS personnel returned to Lower Ley Creek on May 8, 2010 with the objective of better defining the depth of contamination in the creek. A subcontractor, Atlantic Testing (Canton, New York) was hired to use vibracore technology at preselected locations within the creek and to collect cores to a depth of up to 10 feet below the sediment surface. The purpose was to determine the depth of sediment contaminants observed in the November 2009 event. It was difficult to access the banks of the creek at many of the locations of interest and it was necessary to move the vibracore to each of the locations of interest. Six locations were successfully sampled with a duplicate at one of the six locations. A track mounted rig was used to travel along the banks of the creek, often in very heavy vegetation. At selected locations the vibracore was lowered over the area of interest within the creek using a long-arm excavator. Cores were cut and processed on site and samples collected at intervals along the core. At the locations, sampling was conducted up to 10-feet below the sediment/water interface or 1-foot below native soil, whichever was reached first. Sediments were collected from the cores at every foot (the bottom 6 inches of the 1-foot intervals composited). The samples were analyzed for TAL metals, CN, Target Compound List (TCL) Pesticides, TCL PCBs and BNAs and a selected subset were also analyzed for dioxin. The sediment samples were sent to an EPA Region II CLP laboratory for analyses.

During the May 2010 sampling event, the EPA Region II RPM also requested that a swale, located south of the creek and east of 7th street, be examined. Soil/sediment samples from the swale were collected by hand for metal and PCB analyses. SERAS personnel first examined the condition and terrain of the swale before attempting to collect the samples. Much of the swale is difficult to access due to thick vegetation, uneven terrain, and lack of access paths. Seven relatively even spaced locations along the swale were chosen for sampling. Standing water was found in the more southern portion of the swale, while no water was found near the northern part of the swale close to the creek at this time. Trash and other debris were readily apparent in the water on the southern portion of the swale. Samples were collected after driving a Geoprobe sleeve by hand into the sediment to create a core. The sediment was very firm and it was difficult to collect cores by this method at most of the sampling locations. Sediment samples were collected from the cores at depths of 0 to 6 inches and 6 to 12 inches bgs. The swale sediment samples were analyzed for TAL metals and TCL PCBs at the EPA Region II Laboratory.

Additional sediment samples were collected within Lower Ley Creek to be used for toxicity tests. Surface sediment was collected from 10 selected locations previously sampled in November 2009 (R1-1A, R2-16A, R2-13A, R2-2A, R2-12A, R2-8A, R3-9A, R3-11A, R3-5A, R3-3A ["A" indicating surface sediment]) for use in a 10-day toxicity test utilizing *Chironomus tetans* and additional analytical testing to identify current levels of contamination (TAL metals and cyanide [CN]), base/neutral/acid extractables (BNAs), Total Organic Carbon (TOC), pH, and grain size) per method requirements. Samples from five of these locations (R1-1A, R2-16A, R2-8A, R3-11A, R3-3A) were also collected too be used in a 28-day toxicity test using *Hyalella azteca*. Five replicates per treatment (sediment location) were used for each toxicity test. The surface sediment was collected using a ponar launched from an inflatable Zodiac raft. The ponar would clamp shut when hitting the bottom, capturing sediment. The closed ponar was then retrieved with an attached rope and the sediment placed in a stainless steel bowl. A full 2.5 gallon bucket of sediment was collected at each selected location for shipment to a laboratory for toxicological testing. The laboratory performing the toxicity testing was American Aquatic Testing of Allentown, Pennsylvania. The locations selected for these tests were based on the chemistry of surface sediment collected during the November 2009 sampling event. The locations selected were included to represent a range of sediment contamination within the area of interest. Figure 1 shows the sampling locations.

August 2010 Sediment Sampling in the Swale

The purpose of the August 2010 sampling event was to further define the extent of contamination in the swale area, particularly the northeast section of the swale which was found to contain elevated levels of PCBs during the May 2010 sampling event. The southern portion (the furthest upstream) section of the swale was relatively clean, but contamination was found closer to where the swale meets Lower Ley Creek. This resulted in the collection of sediment samples along the swale located just east of sampling location R3-11. Samples were proposed to be collected at depths of 0 to 6 inches and 6 to 12 inches, and the bottom six inches of each foot afterwards to a maximum depth of up four feet with an option of up to 5-feet deep from up to five locations on each of five transects (Figure 3) to better define the extent of contamination along the swale. The terrain made it difficult to sample systematically along transects and 19 locations were instead chosen by the WAM and SERAS scientists in the field throughout the area of interest. The excavator could not reasonably access or maneauver over the northwest bank of much of the swale. In addition, the terrain and thick vegetation increased the time it took to collect each samples. The swale sediment samples were analyzed for TAL metals and TCL PCBs. All of the sampling locations during this round were given the prefix "SB". Each of these locations was only sampled at three depths.

September/October 2011 Soil and Sediment Sampling

SERAS and ERT personnel returned to the site on September 26, 2011. Sampling occurred the week of September 26 and the following week of October 3, 2011. EPA Region 2 requested further investigation of parts of the bank of Ley Creek where dredge spoils may have been historically deposited. Forty-six locations were preselected by EPA and NYSDEC that were representative of the area where dredge spoils were or may have been historically deposited along the banks of the creek. The locations selected are presented in Figure 4. Atlantic Testing Laboratories (ATL) of Canton, New York was again subcontracted to conduct Vibracore™ sediment/soil collection. A track mounted rig was utilized to position the vibracore™ over the sampling location and a 4-inch diameter core was to be use to collect soil/sediment 2-feet below the soil/sediment or to refuse with the option of going to 8-feet or to refuse. If the rig and equipment could not get to a particular location, an attempt was made to hand auger at that location to 0-1' and if reasonably possible, down to 2' below ground surface.

Accessing most of the proposed sampling locations proved difficult due to vegetation. Areas further from the creek were heavily wooded, particularly on the south side of the creek. Closer to the creek channel, dense Phragmites stands often reaching up to 14-feet high made maneuvering near impossible without cutting or matting down the Phragmites. In addition, the vibracore did not work as anticipated and vibracoring did not turn out to be a viable option on land. Cores were either hammered by the rig or, more often than not, driven by hand. The effort to locate and identify the presence of underground utilities at many of these locations prior to digging also proved to be very difficult. Even representative of the utility companies were not sure of the exact location of their respective utilities, particularly in the area of the north bank of the creek, west of 7th North Street. In addition, these same representatives did not access the areas of interest prior to the sampling effort despite numerous notifications. This was due to the nature of the vegetation in the area preventing access. Atlantic Testing matted down the Phragmites in the areas of interest with their track-mounted rig, at which point utility representatives attempted to locate their utilities in areas where sampling was proposed. These proposed sampling locations were identified using GPS and marked with flagging or pin flags.

Because of the difficulties of access, digging, and unknown utilities, much of this sampling effort was performed by hand and, in most cases, soil borings did not go deeper than 2-feet. Ultimately, samples were collected at fifty-three locations well representative of the areas of interest, labeled LLCS-1 through LLCS-53 (Figure 4). Samples were subject to PCB field screening. Select samples were also analyzed for VOCs, SVOC, Metals, Hg, Pest/PCB (confirmatory), and a smaller subset of samples were analyzed for dioxin.

Physical Characteristics of the Study Area

Surface Features

Lower Ley Creek flows through urban developed East Syracuse. Along the area of interest the creek flows through a landfill, under several bridges, along a railroad track, adjacent to several businesses and near a major shopping mall. The bed of the creek is well channeled with steep sides, and the creek depth ranges from 1-14 feet deep but it is generally walkable and only 3 to 5 feet deep over much of its length. The location of the original streambed has been altered by human activity, particularly where it flows through the Salina Landfill. In addition, it is apparent from historical aerial photos that the channel had also been widened and altered by man before 1980. The bottom of the stream is mostly composed of soft sediment, with very little areas of stone or riffle.

Meteorology

The climate around Onondaga Lake is temperate continental. The weather patterns in the area, due to Lake Ontario, result in much more moderated air temperature relative to areas at the same latitude. The mean annual temperature is 47.8°F (8.8°C), with a mean July temperature of 71.1°F (21.7°C) and a mean January temperature of 23.7°F (-4.6°C) (National Oceanic and Atmospheric Administration [NOAA], 2001). Record temperatures range from 102°F (38.9°C) in July to -26°F (-32.2°C) in the midwinter months. The average first occurrence of freezing temperatures in the fall is around November 15, and the average last occurrence of freezing temperatures in the spring is April 8. Moisture enters the area primarily via low-pressure systems that move through the St. Lawrence Valley toward the Atlantic Ocean. Monthly precipitation averages approximately 8.2 cm and is distributed fairly evenly throughout the year. Syracuse area winds are predominantly from the west and northwest.

Geologic Setting

Surface-Water Hydrology

Water flows westerly in Lower Ley Creek towards Lake Onondaga. The movement of water within the stream is generally fairly consistent. There are no areas of rock or riffle although flow does increase after storm events.

Geology

The bedrock geology in northern and central Onondaga County consists of sedimentary rock units from the Paleozoic-age Salina Group, which, in order of oldest to youngest, is comprised of the Vernon Formation, the Syracuse Formation, Camillus Shale, and the Bertie Formation. In the vicinity of Onondaga Lake, only the oldest two of these units outcrop. The Vernon Formation, consisting of red and green shale, underlies Onondaga Lake and is the thickest single formation in Onondaga County. This layer consists of approximately 500 to 600 ft of grey, red, and green mudstones that are relatively soft and erodible interspersed with gypsum seams. Most of this layer is fairly impermeable. In areas to the south of Onondaga Lake, the Syracuse Formation overlies the Vernon Formation. The Syracuse Formation varies from approximately 150 to 220 ft thick and consists of shales, gypsum, and rock salt. Groundwater flows to the north toward Onondaga Lake and is the source of naturally occurring brines in the area. As groundwater flows through the Syracuse Formation, evaporites are dissolved and carried along in the water. The dissolution of the evaporites results in many void spaces in the Syracuse Formation (Rickard and Fisher, 1975), which offer a conduit for the rapid transportation of groundwater. The unconsolidated deposits overlying the bedrock around Onondaga Lake vary in thickness, with much of the lake underlain by approximately 100 ft of deposits which thicken to approximately 328 ft at the mouth of Onondaga Creek at the southern end of the lake. Most of these deposits are glacial in origin but quite variable in size and origin. The layered sequence of deposit within the lake varies greatly from one area to the next. Naturally occurring materials found at the surface may include the glacial deposits, or deposits of more recent origin such as clay, peat, and marl formed in and at the edges of the lake. The area around the lae has been inhabited by people for much of recent history and much of the material in the lake is now found to be fill material and other debris. The glacial deposits found beneath the lake also extend beyond the lake margins and fill the major drainage channels leading into and out of the lake. Deposits within these channels are primarily outwash in origin and consist of sand and gravel, with an interbedded fine component. These outwash deposits are locally heterogeneous and receive recharge from upland areas from both groundwater and surface water flow. Organically rich sediments occur in much of the southern portion of the lake.

Soils

The surface soils surrounding Onondaga Lake consist of glacial origin deposits including till, outwash, alluvial, and glacio-lacustrine sediments. These surface soils tend to be medium-textured, well drained, and high in lime (NYSDEC, 1989; Soil Conservation Service [SCS], 1977). Above the unconsolidated sediments in many upland areas near the site are fill deposits composed of peat, cinders, ash, and Solvay wastes. Significant amounts of soil erode into the streams surrounding the lake during heavy storms. Human activity has altered the natural soil surrounding most of the lake and the original soils are no longer found. These soils are now classified as "made land" and "urban land".

Hydrogeology

Onondaga Lake receives surface runoff from a drainage basin of approximately 248 sq. miles. Surface water flows into the lake via six tributaries: Ninemile Creek, Onondaga Creek, Ley Creek, Harbor Brook, Bloody Brook, and Sawmill Creek. A small amount of additional water is added to the lake through two industrial conveyances. The outlets of several tributaries on the south and west sides of Onondaga Lake border several current and former Honeywell Solvay Wastebeds. Lower Ley Creek borders historical Solvay Wastebeds L and H. Ninemile and Onondaga Creeks account for most of the inflow to the lake, together comprising approximately 62 percent (30.4 percent from Ninemile Creek, 31.4 percent from Onondaga Creek) of the total inflow for the period from 1971 to 1989. Ley Creek, and Harbor Brook accounted for approximately 8 and 2 percent of the total water inflow to the lake, respectively. The combined contributions from all other tributaries are minimal.

Groundwater discharge to surface channels accounts for most of the streamflow in the Onondaga Lake Basin—ranging from 56 percent of streamflow in Ley Creek to 80 percent in Ninemile Creek on the basis of a hydrograph-separation analysis performed by using HYSEP (Sloto and Crouse, 1996). Springs are common at outcrops of carbonate bedrock along Onondaga Creek north of the southern boundary of the city of Syracuse, along Ninemile Creek between Marcellus and Camillus, and in the headwaters of Furnace Brook and Harbor Brook. As a result of spring discharges, base flows in these reaches are sustained, and water temperatures are lower during the summer and higher during the winter than in streams in other subbasins. Groundwater in the southern part of the Onondaga Creek valley is under confined conditions with hydraulic heads tens of feet above land surface (Kappel and Miller, 2005).

Demography and Land Use

The land surrounding the section of Lower Ley Creek is industrial. The surrounding area has been urbanized for many decades and contains numerous industries, a landfill, roads, businesses, homes etc. The creek itself is not used commercially, although it is easily accessable for fishing and other recreation.

Ecology

Historically, Onondaga Lake was a moderately productive mesotrophic lake with some dissolved nutrients and fresh to slightly brackish water. Water in the lake was greenish, as is typical of mesotrophic lakes, likely a result from high concentrations of algae.

There is printed evidence of a much more diverse and different fish community in and around the lake in the past. Nemerow (1964) draws on an account from 1866 where "large numbers of pike, perch, bass, and bullheads" were caught by fishermen. In 1872, "salmon, trout, and bass" were also stocked in the lake. Salmon, along with the Onondaga Lake whitefish, supported a commercial fishery that operated on the lake until 1890, with the whitefish lost by 1897 (Tango and Ringler 1996). Atlantic salmon was extirpated from Onondaga Lake by the late 1800s. In 1927, J.R. Greeley performed the first documented scientific study of fish in Onondaga Lake. He collected twelve fish species from Onondaga Lake, including the white sucker (*Catostomus commersonii)*, shorthead redhorse (*Moxostoma macrolepidotum)*, common carp (*Cyprinus carpio*), golden shiner (*Notemigonus crysoleucas*), emerald shiner (*Notropis atherinoides* Rafinesque), bluntnose minnow (*Pimephales notatus)*, grass pickerel (*Esox americanus.vermiculatus*), banded killifish (*Fundulus diaphanus*), largemouth bass (*Micropterus salmoides),* pumpkinseed sunfish (*Lepomis gibbosus*), and yellow perch. Compared with other local lakes of similar size and volume, however, the lake's fish population was considered neither diverse nor plentiful. This lack of diversity was noted when a second fish survey conducted in 1946 revealed that 90% of 400 fish collected in a three day-period were common carp. The remaining 10% accounted for a total of 13 different species (Ringler *et al*., 1996). The next comprehensive survey of the lake occurred in 1969 by Noble and Forney, who surveyed the fish community of Onondaga Lake using trap nets and gill nets. This study identified 14 species of fish and described the fishery as a warm-water fish community with similar growth rates as other warm-water lakes in the northeastern United States.

In the vicinity of the lake, Ley Creek likely supports a fish community similar to the other large tributaries. Fish sampling has been performed as part of investigative activities associated with General Motor's Former IFG Facility located approximately 3.5 miles upstream of the lake (1.5 miles upstream of the current site investigation) (O'Brien & Gere 2001). The primary species observed as part of those investigations, conducted in 1985 and 1992, included bluegill, pumpkinseed, shiners, bullhead and carp.

Nature and Extent of Contamination

Soil characterization logs are included in Appendix B. Based on these sampling events, elevated levels of contaminants have been found in the stream sediment within the channel and in locations along the banks of Lower Ley Creek (Figures 1 through 4).

Contaminant Fate and Transport

The contaminants of interest are primarily in the sediments of Ley Creek. Some of the sediments may have been placed on the banks of Ley Creek due to historical dredging. The risk assessments indicate how the contaminants may effect ecological or human receptors in or around Lower Ley Creek.

Summary Results

Several sampling investigations conducted by ERT and SERAS in 2009 through 2011 examined sediment, soil, water and biota at Lower Ley Creek and the surrounding area. The resulting BERA and HHRA are included in Appendix C and Appendix D respectively of this document. The soil samples collected from the banks of Lower Ley Creek in August 2010 and the fall of 2011 were not included in the original BERA and SERAS but will be added as a supplemental in 2012. These risk assessments were produced through SERAS and under direction of EPA/ERT, by

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The toxicity test results based on sediments collected in May 2010 may be found in Appendix E. GPS locations of all of the sampling locations are included in in Appendix F. Figures 1 through 4 indicate the sampling locations on an aerial map. The sampling events are roughly outlined above and details of each sampling event and for the goals and analyses of these sampling events may be found in the Site Specific Quality Assurance Project Plan, Lower Ley Creek Superfund Site, Amendment 4 dated September 13, 2001 and included in Appendix H. The data from the sampling events are included in the electronic version within Appendix H and in the two Scribe™ files attached in the electronic version of this document within Appendix I.

The November 2009 sampling event may be found in the first Scribe file, data from the remaining sampling events in the second Scribe file. Some of the sample numbers were accidentally repeated during the second sampling event and created the need for a second Scribe file.

For the streamlined BERA, measured concentrations of selected COPCs in fish tissue were compared with concentrations reported in the literature that are associated with adverse effects in fish. Dietary exposure of piscivorous birds and mammals feeding on prey captured from Lower Ley Creek was also evaluated. Solid-phase toxicity tests were conducted using two invertebrate species. Risk to the aquatic plant community in Lower Ley Creek was assessed by comparing measured concentrations of COPCs in surface water with selected surface water quality benchmarks and by comparing measured concentrations of COPCs in sediment with soil benchmarks for plants.

Exceedances of surface water quality benchmarks and sediment benchmarks suggest potential risk to aquatic plants, benthic invertebrates, and fish. In sediment, inorganics (particulary cadmium [Cd], chromium [Cr] and nickel [Ni]), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and some pesticides resulted in exceedances of screening values, indicating potential risk to aquatic plants and benthic invertebrates. The sediment sampling locations at which the most exceedances of sediment screening benchmarks occurred include R3-3 (PAHs); R2-2 and R2-12 (inorganics); R2-6, R3-9, and R3-11 (pesticides); R2-12 (dioxins/furans); and R2-6 (volatile organic compounds; VOCs).

Reduced growth was observed in invertebrates exposed to sediment samples collected from several locations in Lower Ley Creek; significant mortality was observed in one sample. No significant correlations with measured COPC concentrations in sediment samples were observed within the test results.

Total equivalent concentrations (TEC) of dioxin in fish tissue collected from Lower Ley Creek exceeded concentrations reported to be associated with adverse effects in fish.

Piscivorous mammals are at risk from dietary exposure to measured total PCB concentrations in fish from Lower Ley Creek. Piscivorous birds are at risk from dietary exposure to PAHs and potentially Cr.

Because no dose-response relationship was observed in the toxicity tests, no-effect concentrations for direct toxicity of inorganics and PAHs to *Hyalella azteca* and *Chironomus dilutus* were identified and compared with maximum concentrations measured during the 2009 sampling event, screening benchmarks, and effect concentrations for growth and mortality in *H. azteca*. The maximum no effect concentration for exposure of *H. azteca* to PAHs (45.19 mg/kg) was lower than the measured concentrations at which significant effects on growth and survival were observed. A LOAEL concentration for adverse effects on growth and survival of 54.78 mg PAHs/kg (growth) and 156.56 mg PAHs/kg (survival) were identified.

Because concentrations measured in samples collected in 2009 were higher than screening benchmarks and the observed no-effect concentrations in the toxicity tests, the following inorganics were retained as COPCs potentially resulting in direct toxicity to benthic invertebrates: arsenic (As), Cd, Cr, copper (Cu), lead (Pb), mercury (Hg), Ni, silver (Ag), and zinc (Zn). The maximum no-effect concentration observed in the toxicity tests was identified as the preliminary remediation goal (PRG) (As, 5.6 mg/kg; Cd, 6.4 mg/kg; Cr, 94.2 mg/kg; Cu, 102 mg/kg; Pb, 87.8 mg/kg; Hg, 0.29 mg/kg; Ni, 34.4 mg/kg; Ag, 2.1 mg/kg; and Zn, 342 mg/kg). A remedial action objective of 0.8 mg Hg/kg was identified for Onondaga Lake (EPA 2005). The concentration of 0.29 mg Hg/kg identified in this risk assessment would meet the objective of eliminating Ley Creek as a source of Hg to Onondaga Lake.

Site-specific bioaccumulation factors for PCBs were calculated for forage fish in the upper, middle and lower sections of Lower Ley Creek. LOAEL-based and NOAEL-based sediment concentrations were calculated to identify a range of sediment PCB concentrations below which adverse effects on wildlife receptors would not be expected.

Sediment concentrations that would result in calculated HQs less than 1.0 for mink (the most sensitive receptor at this site based on the food chain models) were calculated. The LOAEL-based sediment PCB concentrations protective of ecological receptors ranged from 0.08 to 2.28 mg/kg. The NOAEL-based sediment PCB concentrations protective of ecological receptors ranged from 0.01 to 0.23 mg/kg.

Based upon the results, risk characterization, and interpretation, ecological risks exist at the Site from contaminants in sediments, specifically PAHs and several inorganics including Cd which may pose a risk via exposure to surface water in addition to exposure to sediment. Ecological risk exists from concentrations of dioxin-like COPCs in fish tissue, and PCB concentrations in sediment and forage fish pose a risk to piscivorous mammals.

The HHRA was performed to evaluate the data collected during the November-December 2009 sampling. Data concerning chemical concentrations in sediment, surface water, and fish tissue were evaluated. Sample data were generally pooled and addressed as one site-wide exposure area, with the exception of the Dredge Spoils Area which was evaluated separately. Recreational users (both adults and children) and future construction workers were the primary receptor groups evaluated in the HHRA. Potential exposure pathways included contact with Ley Creek sediments and surface water via incidental ingestion and dermal contact, as well as potential consumption of contaminated fish. Exposures were quantified using exposure factors generally obtained from USEPA guidance, and were selected to represent both a reasonable maximum exposure (RME) and central tendency exposure (CTE) scenario for each pathway. Non-cancer and cancer risks were quantified separately, in accordance with USEPA guidance, and compared to USEPA target levels of risk = 1×10^{-6} for carcinogenic effects and HQ=1 for non-carcinogenic effects. The HHRA identified risks greater than these targets for most of the recreational receptor scenarios evaluated. Primary risk drivers were PCBs, arsenic and mercury in fish tissue, PAHs (e.g. benzo(a)pyrene) in sediments, and PCBs, PAHs, and chromium in the Dredge Spoils Area.